# COLORED STONES
## ASSIGNMENT 14
# CULTURED PEARLS
### IDENTIFICATION, PRODUCTION, MARKETING, BUYING

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## I. INTRODUCTION

The cultured pearl is probably the most popular and widely used of all gem substitutes. This is partly because numerous problems in the natural pearl industry have caused production to fall below potential demand. Fortunately fine quality cultured pearls are available to fill the void.

The better qualities of cultured pearls are beautiful and desirable. They possess the color, luster, texture, and other external characteristics of a true pearl. Their introduction marked a marvelous improvement over the best earlier imitations.

Although cultured blister pearls had been produced for centuries, the spherical cultured pearl was unknown before the 20th century. Early in this century, three Japanese experimented intensively in an effort to produce spherical cultured pearls. Although the late Kokichi Mikimoto's important position in the industry led many to believe that he developed the spherical cultured pearl, Dr. A.R. Cahn of the U.S. Bureau of Fisheries corrected this impression in his noteworthy report "Pearl Culture in Japan" (Fish and Wildlife Service, U.S. Department of Interior, Washington, D.C.). Two other men, Tatsuhei Mise and Tokichi Nishikawa, developed the spherical cultured pearl, independently arriving at the same correct conclusions at almost the same time.

Mise was a carpenter; his stepfather awakened his interest in pearls after returning from a government-sponsored trip to inspect oyster beds off Australia. Although he had no training to prepare him for such an endeavor, Mise started pearl-culturing experiments. According to Cahn, "Available information points to the conclusion that he was the first person to develop a spherical cultured pearl." His first successful effort, a tiny pearl formed around a lead nucleus, was apparently completed before 1904. He applied for a patent early in 1907, but it was refused. In October of the same year, Nishikawa, a trained zoologist who had left a position in the Japanese Bureau of Fisheries to do experiments in spherical pearl culture, applied for a patent on a very similar method; this was granted nine years later (seven years after his death.) Although Nishikawa's application was made later than Mise's, Mise's was ruled an infringement of Nishikawa's. In 1908, however, Nishikawa signed an agreement with Mise that made the use of the two methods common property, thereby seemingly acknowledging the prior success of Mise's endeavors. The nature of the patents obtained by Nishikawa suggests that his method was the more practical one.

Although Nishikawa was Mikimoto's son-in-law, they were not on friendly terms. After Nishikawa's death, however, Mikimoto made a working arrangement with Nishikawa's son, and since that time the Mikimoto firm has used that general method of spherical pearl culture. Over the years, the late Mikimoto made great contributions to the development of the industry. Taking the nearly simultaneous discoveries of Mise and Nishikawa, as a starting point, Mikimoto created the cultured pearl industry as it exists today; the methods for rearing young oysters and most of the pearl-farming methods explained in this assignment are his.

### A. TERMINOLOGY

The terms **cultured** and **cultivated** are both used for whole, artificially propagated pearls. Either term may or may not make these pearls sound more desirable, depending on the sense in which it is understood. In Japan, pearls are "cultivated" on pearl farms, in the sense of tending them as farmers tend agricultural crops, but to many people, cultivated may imply more desirable, in the sense in which cultivated flowers are more desirable than wild ones. The term "cultured" can also imply improvement or refinement — thus, a better product — but the biological definition of the word gives grounds for its preference, since it simply indicates organic growth, stimulated and controlled by man. Any term that will confuse the public as to the real character of a gem material or substitute is to be avoided; dealers in natural pearls prefer the term cultured to cultivated, believing that it is less misleading.

France was the first country where litigation took place over pearl terminology; the result was to establish "perle de culture" for the Japanese substitutes and "perle fine" for natural pearls. The first term was unfortunately translated into English as cultured pearl, when in fact the English-speaking Frenchman never says cultured pearl; he says **culture pearl** for a product of pearl oyster culture. (Some members of the pearl trade regret that they did not adopt the term "plated pearl," to indicate the similarity of cultured pearls to plated gold or "veneered mother-of-pearl.")

Because Mikimoto was long believed to be the originator of cultured pearls, the habit of calling them "Mikimoto pearls" became widespread. The use of this term by retailers may give inappropriate publicity to that one organization or even misrepresent cultured pearls not actually produced by that organization. Therefore, the general use of the name Mikimoto as a descriptive term for cultured pearls should be avoided.

Educational efforts by cultured pearl producers have aroused unusual public interest in pearls, but they have also (by implication) given the public some incorrect ideas. Gemological students are in an excellent position to correct these misunderstandings and to establish and maintain a lasting interest in both cultured and natural pearls.

## II. TYPES OF CULTURED PEARLS

### A. CULTURED WHOLE PEARLS WITH MOTHER-OF-PEARL NUCLEI

Cultured whole pearls are produced by the insertion of a mother-of-pearl bead into the mantle of a pearl-bearing mollusk, usually *Pinctada martensii,* although *Pinctada maxima* and *Pinctada margaritifera* are also used. The resulting nacreous coating is ideally about one-half-millimeter thick; often less, occasionally more.

### B. THREE-QUARTER OR HALF CULTURED PEARLS

Many whole cultured pearls have unsightly blemishes. Removal of these by sawing produces three-quarter pearls or half pearls, depending on the amount of material removed.

### C. CULTURED BLISTER PEARLS

A blister pearl is a natural calcareous formation that grows attached to the shell of the mollusk as explained in the pearl assignment. A cultured blister pearl is one whose growth is artificially induced. As early as the 13th century, the Chinese used clay pellets or spherical mother-of-pearl beads to stimulate the formation of freshwater blister pearls; they also used knob-like pieces of bone, wood, or brass, and even small leaden images of the Buddha. The shell was gently opened with a spatula of bamboo or pearl shell, and the foreign bodies were placed in rows on the inner surface of both lips of the shell using a forked bamboo stick. The mollusks were tended in shallow ponds adjoining rivers; after a few years the growths were cut out.

Today, three-quarter or half sphere mother-of-pearl nuclei are placed flat side down on the inside of the shell of the saltwater mollusk *Pinctada maxima* to produce cultured saltwater blister pearls.

### D. MABE ASSEMBLED CULTURED PEARLS

Mabe (pronounced MAH-be) pearls are assembled from a cultured blister pearl and a mother-of-pearl backing. The blister is produced by placing a half bead, usually of soapstone, alabaster, or plastic flat side down against the shell. (A bead of much larger diameter than would normally be tolerated by the mollusk can be used.) The resulting formation is cut from the shell, the half bead removed, and the hollow nacreous half dome cemented, usually over a mother-of-pearl bead to a mother of pearl base. The bead is used so that the mabe can be half drilled and pegged for mounting. See figure 1.

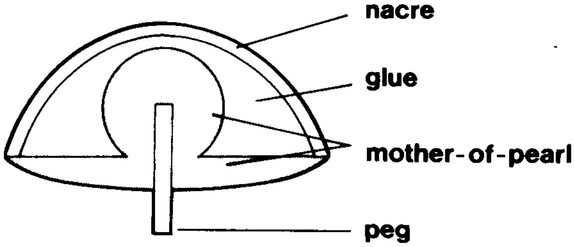


Figure 1

### E. FRESHWATER MANTLE-TISSUE NUCLEATED CULTURED PEARLS

The primary site of freshwater pearl culture is at the Hirako Reservoir, an arm of Lake Biwa, in Shiga Prefecture, Japan. A large freshwater mussel of the species

Figure 2 A FRESHWATER CULTURED PEARL FARM AT LAKE BIWA, JAPAN.

*Hyriopis schlegeli* (pronounced harry-OPP-sis SCHLAY-guh-lye) is used as the host mollusk. This species requires three to four years to reach operable size. It was soon learned that large mother-of-pearl nuclei caused a 50% death rate and that less than 10% of the pearls produced were saleable. As a result, small squares of mantle tissue

Figure 3 FRESHWATER MUSSELS AFTER IMPLANTATION AT LAKE BIWA, JAPAN

FIGURE 4 FRESHWATER CULTURED PEARLS

(sometimes taken from a different species of the genus Odonata, which has a colorful nacre) are now inserted instead of mother-of-pearl nucleus. Up to fifty squares of mantle tissue can be used in each mussel. On the whole, the pearls produced have fine color and luster. To some extent the shape of the inserted mantle tissue can influence the shape of the pearls obtained three years later. Normally these pearls are quite irregular (baroque) and average six by three millimeters. These freshwater mantle-tissue nucleated cultured pearls have become important in the cultured pearl market.

Freshwater cultured pearls with mother-of-pearl nuclei are being produced at Lake Biwa, but constitute less than 5% of the production there.

Since 1974, China has produced freshwater mantle-tissue nucleated cultured pearls using the mussel *Cristaria plicata* (pronounced cris-STAR-ee-uh pli-CAH-tuh). Some success has been achieved in northern Australian waters by inserting mantle tissue in saltwater mollusks, but marketable quantities of pearls have not yet been produced. These too are nearly always baroque.

## III. OYSTER CULTURE

There are two basic methods of obtaining host mollusks. Although wild mollusks are still gathered annually for use in cultured pearl production, the main supply is raised from cultured **spat** on the pearl "farms." (The spat is the free-swimming larval stage that ends when the young oyster attaches itself permanently to a solid surface.) Wild three- and four-year-old pearl oysters are gathered by diving girls operating from small launches and skiffs. At gathering time, several hundred to a thousand people are so employed. The pearl oysters are collected from beds at a depth of 1 to 10 meters (1 meter = 3.28 feet) and taken to pearl culture farms, where they are distributed over empty beds in shallow water. This is done in early autumn, and the pearl oysters are undisturbed until they are collected again the following spring. Only the healthy ones receive nuclei for cultured pearl production.

The rearing of very young oysters (spat) started around 1924, and has since become the most important source of these mollusks. Experiments by Mikimoto demonstrated that the freely moving spat develop a sensitivity to light that makes them seek dark areas just before settling to the bottom to attach themselves to some undersea object. Therefore, he developed a darkened cage. The cages, which measure about 33 x 20 x 8 in., are made by covering a heavy wire frame with small wire mesh. Each cage also has several shelves of wire mesh. The wires are given a rough surface by dipping them in tar and a mixture of cement and sand. Black boards are then fastened to the sides and bottom to produce a dark area.

The cages are suspended about six meters below the surface. The spawning period is from July to September, and the cages remain out until late in November. Fantastic numbers of spat collect in each cage, on the average between 7,000 to 10,000. They are transferred from the collecting cages to rearing cages in November. Natural enemies such as the starfish, eel, and octopus feed on pearl oysters if given a chance, but the cages protect against these predators so that a high percentage of the mollusks survive. Certain other enemies are difficult to guard against. Barnacles and seaweed cause damage that can be prevented only by cleaning the cages. Sudden temperature changes caused by shifting ocean currents may be damaging, and occasionally the so-called red tide — seawater discolored by tremendous numbers of plankton (a minute marine organism) — causes wholesale destruction of pearl-bearing mollusks. Fortunately, this phenomenon is comparatively rare.

At the age of about one year the oysters, which by this time have grown to about one inch in shell diameter, are sown in water over a fairly rough bottom. Nothing further is done to them for about another two years. During the summer of the third year of their captivity, the pearl oysters are collected by women divers and brought to barges, where shells are selected for nucleus insertion and cleaned of incrusting organisms. Undersized shells are returned for another year of growth. Those that are too distorted or too old are discarded.

## IV. PEARL CULTURING

When the oysters are three years old, they are collected. Those in which nuclei are to be inserted are cleaned and brought to the technicians who perform this delicate operation. Usually, the pearl oysters are transported to this area in baskets that then hang in the sea from rafts near the scene of the operation. The mollusks are induced to open and spread the two valves of their shells by various methods. The major producers generally place them on the wharf near the technicians, where many will open in a short time; another method is to place them in trays of running water. A bamboo wedge is later inserted to keep the shell in an open position. The nucleating

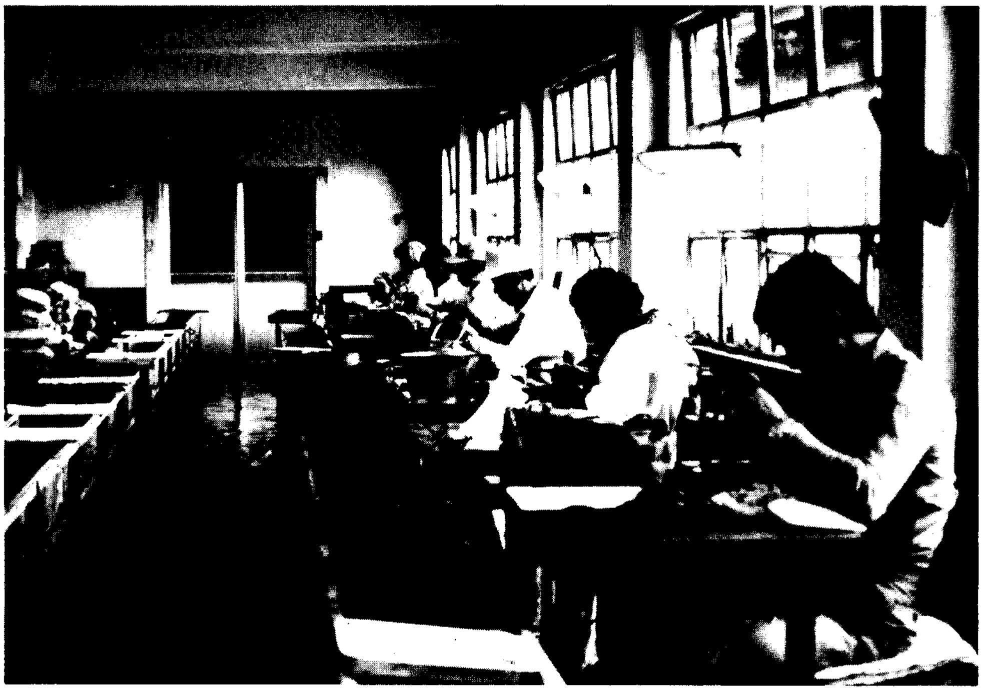


FIGURE 5 TECHNICIANS IMPLANTING NUCLEI AT A PEARL FARM IN AGO BAY, JAPAN.

operation must take place shortly after the wedge is inserted; being forced to remain open for more than two hours is likely to produce sufficient fatigue to cause death after nucleation. Wedging must be also done with great care, because breaking the shell edges or other rough handling may cause a dangerous reduction in the animal's vitality and a resulting decrease in the quality of the pearls, even if the mollusk survives.

The opened mollusk is clamped to the technician's table. He or she folds back the mantle tissue, makes an incision in the foot of the animal and opens a small channel into the main mass. Graft mantle tissue that has been prepared in advance is then passed down the incision, followed by the nucleus, which is placed just above the mantle tissue. The foot mass is then smoothed back to close the opening and the wedge is removed from the shell, unless a second operation is planned. Another nucleus can be inserted elsewhere in the body; much greater care and skill is required for a second operation. It is even possible to insert a third nucleus, but the most extreme delicacy is required; this is rarely attempted except with small nuclei.

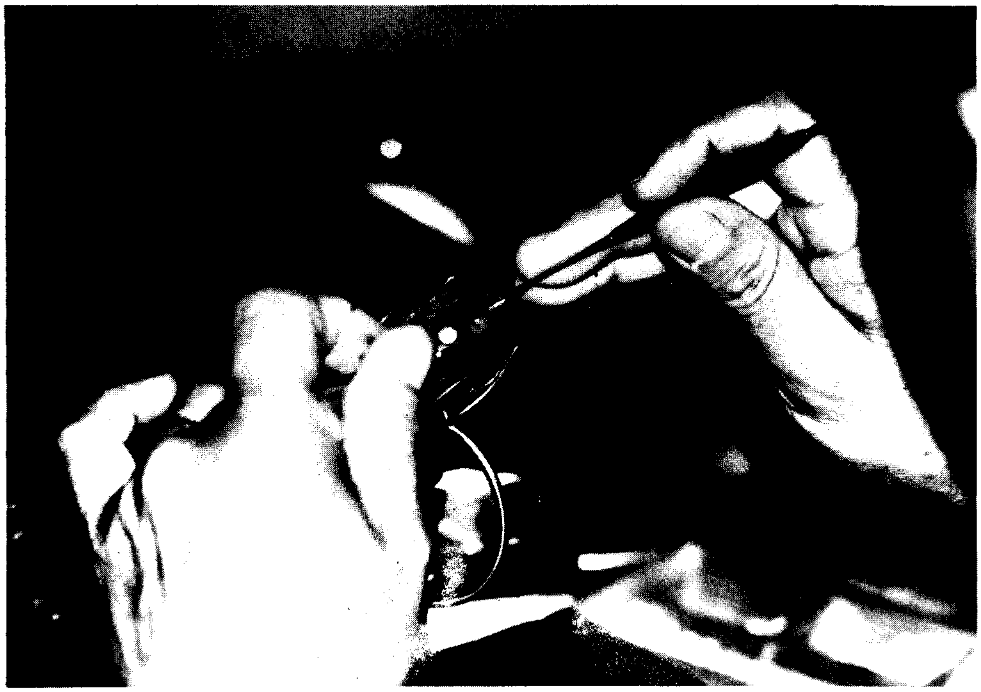


FIGURE 6 A TECHNICIAN INSERTING A MOTHER-OF-PEARL BEAD IN A SALTWATER MOLLUSK

At one time it was thought necessary to actually sew the nucleus into a sac of mantle tissue before placing it in the host mollusk, but this proved to be unnecessary. Tissue containing essential epithelium cells is still obtained from the mantles of living mollusks selected for this purpose; only the portion of the outer mantle surface facing the shell is used. Today, however, it is simply cut into small squares, each large enough to cover about one-third of a nucleus. To produce the finest quality pearls, the outer surface of the mantle tissue (the one on the shell side) must be in contact with the nucleus. A sac then forms around the pearl, produced by the regeneration of these epithelial cells (the same cells that construct the shell of the mollusk).

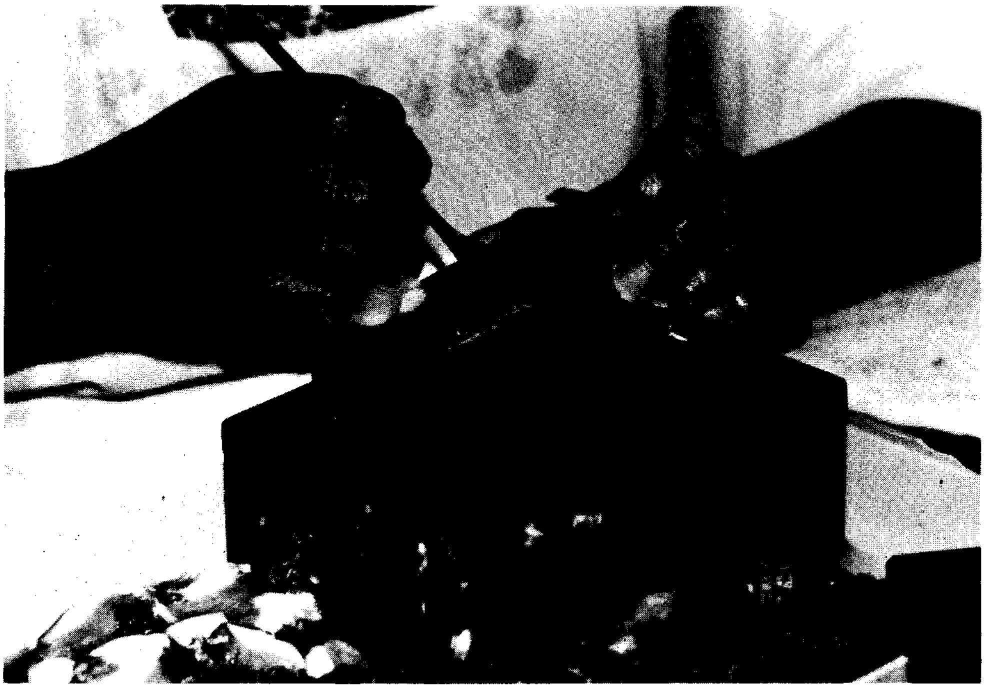


FIGURE 7 A TECHNICIAN PREPARING SQUARES OF MANTLE TISSUE

The nucleus is made of mother-of-pearl from the shells of large freshwater mollusks found in the United States along the Mississippi river and some of its tributaries; this source has provided material of the greatest thickness and strength. Small cubes are cut from the shell and abraded into spheres by rotating them in a ball mill or between sheets of iron; they are then polished by finer abrasion in cotton bags. **The ultimate size of the cultured pearl is determined almost entirely by the size of the nucleus.**

The mollusks that have been operated on are placed in special cages suspended from rafts anchored in sheltered water. After four to six weeks the pearl oysters are inspected and those that have not survived the ordeal are removed. The cages are then moved to a permanent position and suspended from rafts at a depth of two to three meters. For approximately 3½ years they remain undisturbed, except when the shells are cleaned of incrusted growths, in order to keep the mollusks healthy. After each cleaning, they are placed in freshly tarred cages. Harvesting starts in late November and continues through February. Some operators who feel that nacre deposition in the cold water months is more lustrous and adds materially to pearl quality delay harvesting until just before Christmas.

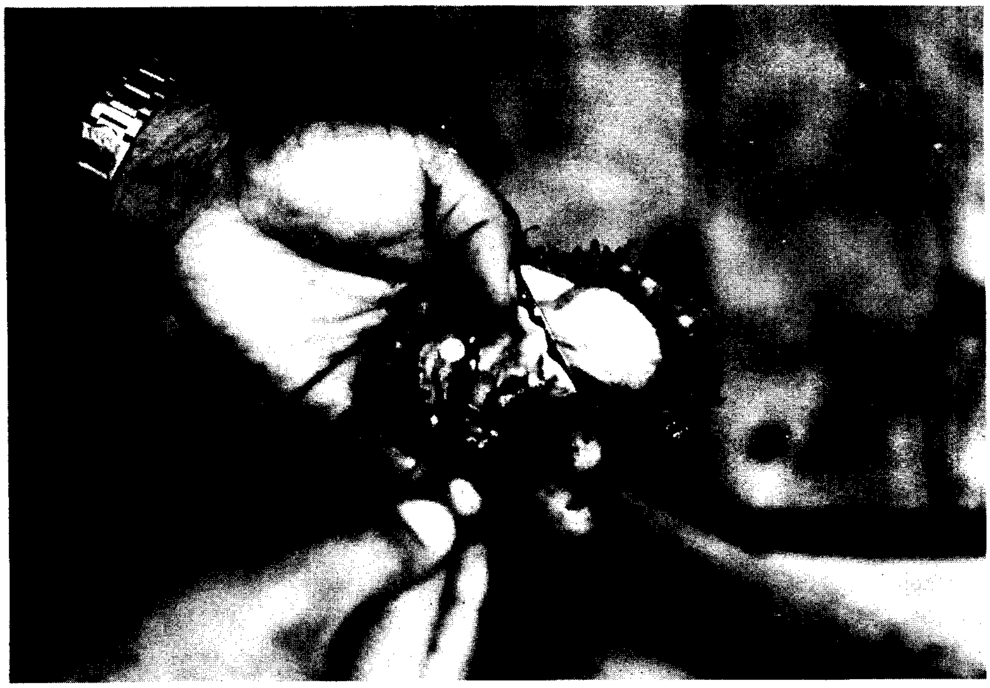


FIGURE 8 HARVESTING A SALTWATER CULTURED PEARL

## V. GRADING THE PEARLS

After the pearls have been removed and cleaned carefully to avoid scratching, they are graded for size with sieves. Next they are counted and graded for quality. The first grading sorts the pearls into good, medium, and poor categories, called A, B, and C. Then a more exact grading separates them into Aa, Ab, Ac, etc. The A grade usually includes all spherical or nearly spherical pearls that have good luster and are not discolored. The B grade includes baroques of good color and luster and spherical or nearly spherical pearls of medium color and luster. Some may be bleached or dyed to improve color. C grade pearls are of little or no value as gems; they are used primarily for the pearl "medicine" valued so highly in oriental countries. Usually only the three A grades are used in better quality necklaces; B grades are used mostly for rings, brooches, buckles, and other ornamental jewelry.

## VI. STRAND PREPARATION

Pearls for necklaces are first examined for blemishes and marked with black ink to indicate the starting point of the drill hole. Drilling is done with a 3/4-millimeter steel wire ground to a triangular point. The wire is mounted in a chuck attached to the spindle of a small electric motor. The pearl is held in a chuck that can be moved forward as the hole is made. Formerly, the hole was drilled slightly past the center and then completed from the opposite side. Centering to ensure that the two holes meet properly was done by inserting a small bamboo sliver in the first hole and centering to a small hole in the back of the pearl chuck. Today most drilling is done by a machine that drills from both sides at once.

To assemble a graduated strand, an expert matches drilled pearls for color, luster, and size and selects pairs of the same size, from large to small. Each pair is placed in parallel grooves, one above the other, on a tray covered with black lintless cloth. Finally, the large center pearl is selected. Stringing is then done by another expert and the weight and quality are recorded. Strands of similar size, color, quality, and length are tied together in groups called hanks and reweighed for marketing in lots. The standard unit of weight for cultured pearls is a **momme** (pronounced MOM-meh), which is equal to 75 pearl grains or 18.75 metric carats. (Note: The word **strand** refers only to a number of pearls strung together; the word **necklace** means a strand of pearls with a **clasp.**)

## VII. PEARL GROWTH

Misleading reference is often made to "seven-year," "nine-year," or "twelve-year" cultured pearls. The average life span of the Japanese mollusk is eight years, but the best nacre production occurs between the ages of three and seven years; thus, as explained previously, nuclei are not introduced until the mollusk has reached the age of three and attained sufficient size. Therefore, for the average Japanese mollusk, the maximum time for nacre accretion is five years. In actual practice, since 90% of nacre accretion takes place in the six months of the year when water temperatures are highest, most nuclei are left in the mollusk from the beginning of the first growing season to the end of the third season, 3½ years later. However, since the nacre produced during the fifth year may actually detract from the beauty of the pearl, the usual cultivation time is four years. Therefore, reference to seven or more years more accretion to explain size or quality difference are incorrect. Smaller or lower quality cultured pearls may only be left for two or even one year.

The size of a cultured pearl is determined not by the time it is in the mollusk but by the size of the nucleus. The average radial rate of nacre accretion in Japanese pearls is near 0.15 mm per year, whether the nucleus is small or large, and the largest Japanese saltwater cultured pearls reported have diameters of approximately 12 mm and nuclei of about 10 mm. In equatorial waters, where higher water temperatures exist all year, nacre accretion is much faster (up to 20 times the usual Japanese rate) and pearls of significantly greater diameter have been produced. The larger host mollusk used also allows the pearls to grow to larger sizes. Saltwater cul-tured pearls in the 13- to 15-mm size range and larger are exclusively South Seas products. At the other end of the size range, some as small as 1 mm in diameter have been produced, but the minimum commercial size is about 1½ mm.

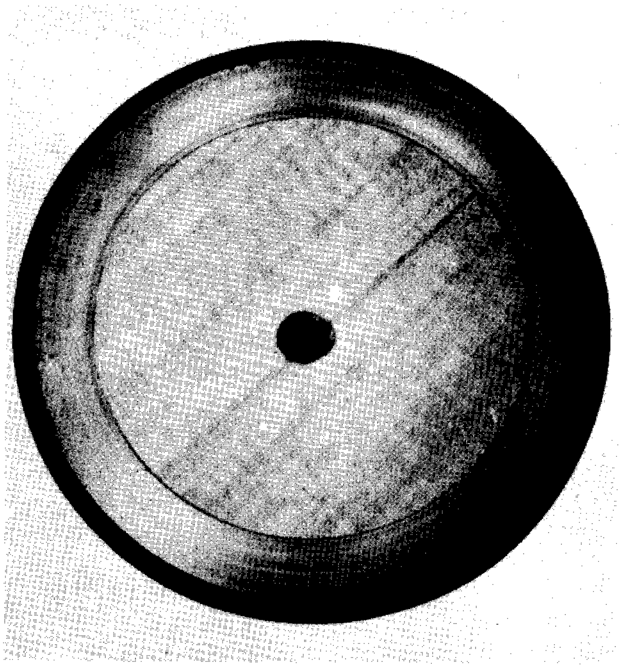


FIGURE 9 CROSS SECTION OF A DRILLED CULTURED PEARL

## VIII. STRUCTURE

Nacreous and prismatic crystalline materials, the same as those that compose natural pearls (with perhaps fewer conchiolin layers), form the layers that cover the nucleus of a cultured pearl. The mother-of-pearl used as the nucleus in cultured pearls is formed similarly to pearls; both substances are composed largely of tiny prismatic crystals. However, mother-of-pearl differs from the true pearl substance in that it is deposited in nearly plane (flat) layers.

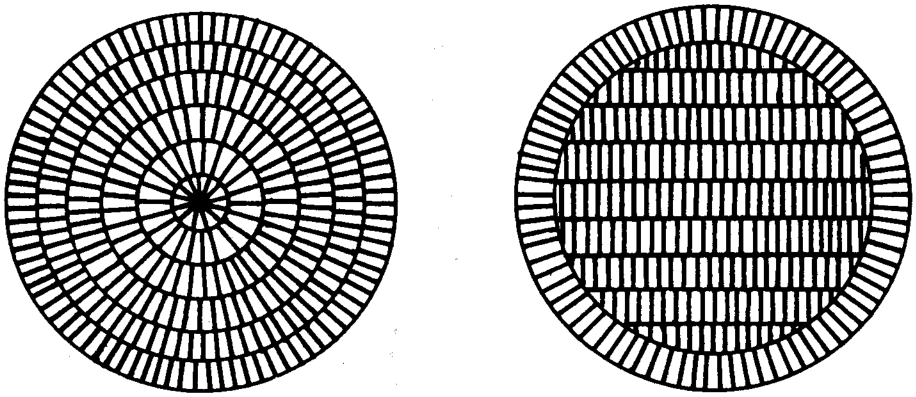


FIGURE 10 SCHEMATIC REPRESENTATION OF THE STRUCTURE OF NATURAL AND CULTURED PEARLS. FIGURE 10a IS AN IDEALIZED DRAWING OF A NATURAL PEARL'S STRUCTURE. FIGURE 10b REPRESENTS A CULTURED PEARL'S STRUCTURE.

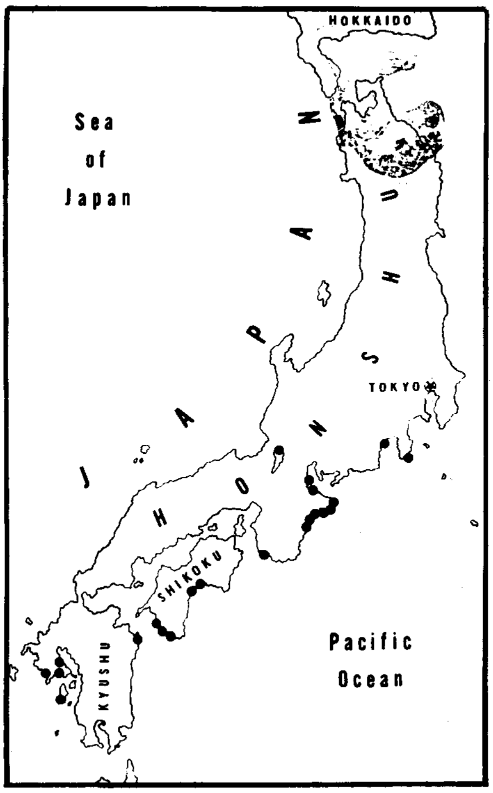
To suggest that cultured pearls contain only a small nucleus, similar in size to the irritant in natural pearls, is unethical because it is obviously untrue. Occasionally, cultured pearls do have comparatively thick nacreous coatings, but these are usually layers of average thickness. Many sellers of whole cultured pearls have intimated that producers were successfully using natural seed pearls for nuclei instead of mother-of-pearl beads. However, proof has never been submitted to the Institute that pearls of commercially important size have been produced using a natural seed-pearl irritant.

## IX. CULTURED PEARL SHAPES

The usual shapes produced are round, button, oval, pear, egg, and baroque. Very few cultured pearls are true spheres. (See illustrations of pearl shapes in Assignment #13.)

## X. SOURCES

Japan is the major source of cultured whole pearls. The culture farms are located in Mie Prefecture (on Ago Bay, Gokasho Bay, Matoya Bay, Nie Bay, and others) as well as Nagasaki, Wakayama, Kyushu, and other prefectures, as indicated on the



accompanying map. Minor quantities of cultured blister pearls are produced in the Philippines. The nacreous half domes used for mabes are produced in Japan and the South Seas.

Mikimoto operated experimental culture stations before World War II on the islands of Palau and Celebes in the South Pacific. Palau was chosen because of the varied colors of natural pearls found in that area, and a station was established at Celebes because of the very large natural pearls produced there. Because it was difficult to keep the captive mollusks alive long enough to produce attractive pearls, both stations were commercial failures. Japanese firms have established new facilities in several locations. Among these are Australia (in Brechnock Harbor, between Augustus Island and the northern coast) and a now nationalized Burmese location. Since 1978, Tahiti has also been a source; most operators are French or Tahitian. Because of the many production problems in equatorial areas, however, the quantity of cultured pearls available from these new sources is very limited.

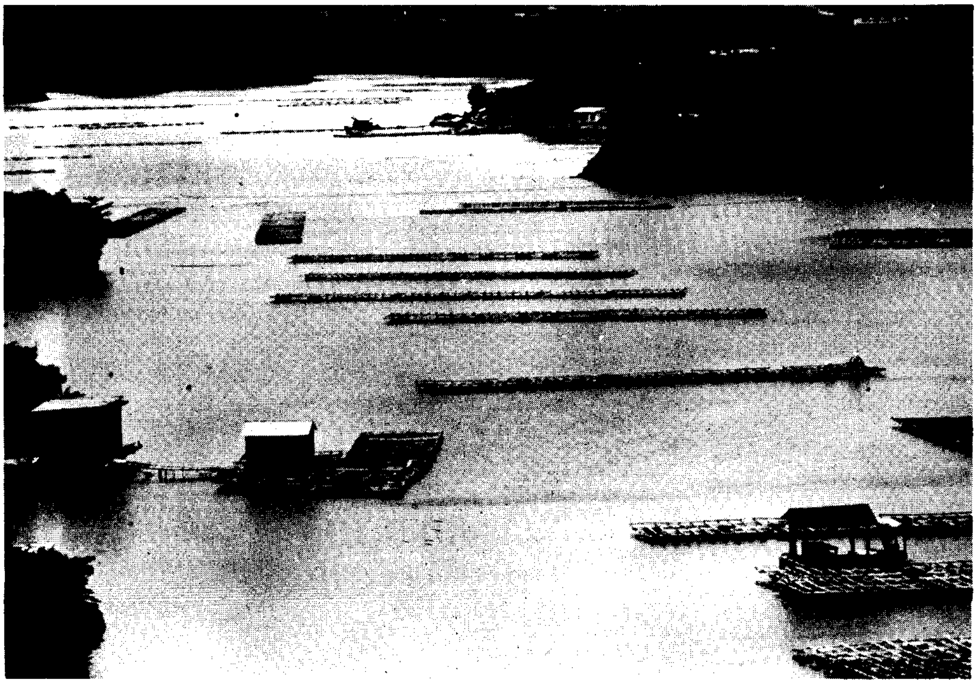


FIGURE 11 A SALTWATER CULTURED PEARL FARM AT AGO BAY, JAPAN.

## XI. PHYSICAL AND OPTICAL CHARACTERISTICS

### Physical

| | |
|---|---|
| Chemical Composition | Outer nacreous layers: same composition as the natural; i.e., calcium carbonate, $CaCO_3$. |
| Crystallographic Character | The outer nacreous layers are the same as the natural. |
| Cleavage | None |
| Fracture | Uneven |
| Hardness | 2½ to 4 |
| Toughness | Same as the natural. If the outer nacreous layers are too thin, they may crack or quickly wear through to the nucleus. |
| Streak | White |
| Specific Gravity | 2.72 to 2.78; higher than most natural pearls but lower than most freshwater pearls. The high S.G. is caused by the density of the mother-of-pearl nucleus (whose S.G. is 2.78 or more). Exception: mantle-tissue nucleated cultured pearls can have an even lower S.G. than natural pearls. |

### Optical

| | |
|---|---|
| Degree of Transparency | Same as the natural (translucent to opaque). |
| Luster | Same as the natural (varies from dull to almost metallic, fracture surfaces are pearly to dull). |
| Phenomena | Same as the natural (orient). |
| Characteristic Inclusions | None |
| Pleochroism | None |
| Refractive Index | Same as the natural (1.53 - 1.686). |
| Birefringence | Same as the natural (0.156). |

| | |
|---|---|
| Dispersion | None |
| Optic Character | Same as the natural (doubly refractive). |
| Ultraviolet Fluorescence | None to strong light blue, yellow, green, or pink under both short and long wavelengths. Natural color black cultured pearls fluoresce weak to moderate red or brown under strong long wavelengths. |
| Color-Filter Reaction | None |
| Absorption Spectra | Vary widely; no diagnostic value. |

(Note: Although the equipment necessary for X-ray testing is not readily available to gemologists, the results of such testing are listed for the sake of completeness.)

| | |
|---|---|
| X-ray Fluorescence | Weak to strong yellow, depending on nacre thickness. Black pearls are usually inert. |
| Transparency to X-rays | Semitransparent |
| X-radiography | Nucleus is lighter in tone than the dark, concentric, outer nacreous layers. |

Effects Caused by:

| | |
|---|---|
| Heat | Same as the natural (excessive heat may cause pearls to burn, turn brown, split, or crack; prolonged moderate heat may cause dehydration). |
| Acids | Same as the natural (attacked violently by all acids). |
| Irradiation | May turn gray. |

## XII. SEPARATION OF CULTURED FROM NATURAL PEARLS

Of all gem materials, pearls pose the greatest testing difficulty for the jeweler. It is a common and dangerous error for the jeweler to attempt an identificaton based on a few indications from tests that are unreliable at best. Often, because of the numerous problems involved, the jeweler's only sensible alternative is to send the pearls to a properly equipped laboratory for identification. Even the large jewelry store is much less well equipped for testing pearls than for testing colored stones and diamonds. The expensive X-ray equipment necessary to identify pearls conclusively is only useful for that purpose; moreover, it is dangerous to operate except by fully trained technicians. As a result, almost all of the pearls so tested in this country are handled by the two gemological laboratories equipped with such units: the Gem Trade Laboratories of the Gemological Institute of America in Santa Monica, California and New York City, New York.

### A. X-RAY TESTING

X-ray tests can be divided into two principal types: **fluorescence** and **radiography.** X-ray diffraction has been used but can only be done on loose individual pearls. Even then, the result may not be diagnostic, so the method is used very little, if at all, except by one or two European laboratories.

### B. X-RAY FLUORESCENCE

Most saltwater natural pearls do not fluoresce when subjected to X-radiation, while almost all cultured pearls show medium to strong fluorescence, depending on nacre thickness. This phenomenon is apparently caused by the excitation of manganese in the freshwater mother-of-pearl nucleus. Certain exceptions reduce the effectiveness of this test when it is used alone (without radiography):

(1) Almost all **freshwater** pearls also fluoresce strongly, since they are composed of essentially the same elements as mother-of-pearl.
(2) A significant percentage of very white saltwater natural pearls from Australian waters fluoresce, although very weakly.
(3) Very rarely, saltwater natural pearls from other areas may show weak fluorescence under X-rays.
(4) Dyeing agents reduce the intensity of fluorescence, and cultured pearls that have been dyed with certain metallic compounds do not exhibit any fluorescence, because the metallic components of the dye mask their normal fluorescence.
(5) Very thick coatings of nacre also mask the fluorescence of the mother-of-pearl nucleus, especially in some rare South Sea cultured pearls.

Thus for various reasons, X-ray fluorescence is not completely reliable when used alone. However, it can give a quick indication; if all of the pearls fluoresce, the strand is most likely made up of freshwater natural or cultured pearls, or saltwater cultured pearls with a mother-of-pearl nucleus; if none fluoresce, a saltwater natural strand is indicated. If some fluoresce and others do not, a mixed strand is a possibility; the pearls that fluoresce may be marked, to facilitate separation after confirmation by X-radiography.

To positively identify pearls, X-ray fluorescence must be used in conjunction with X-radiography, which is explained below.

## C. X-RADIOGRAPHY

### 1. Photographic Method

The photographic method involves the transmission of a wide beam of X-rays through a pearl or strand of pearls onto film to produce a **radiograph** or shadow image of its structure. Conchiolin, which makes up the main division between the layers of crystals, is more transparent to X-rays than the other constituents of the pearl. Therefore, the portion of the beam passing through the conchiolin undergoes less absorption and thus creates a stronger image on the film. The resulting pattern made by the onion-like layers of the natural pearl reveals its true nature. In most cultured pearls, only one conchiolin ring will show up, and the outer nacreous area will be darker in tone than the mother-of-pearl nucleus on the radiograph. Rarely if the orientation of the pearl is just right, the flat, parallel layered structure of the nucleus may show. A radiograph of a natural strand is shown in figure 12A, and one of a cultured strand in figure 12B. This method of testing provides a permanent record giving **positive** results with the right equipment, clear radiographs, and interpretation by qualified personnel. Interpreting pearl radiographs requires considerable experience and a sound knowledge of the various structural peculiarities of both natural and cultured pearls.

Note: Mounted pearls may have to be removed from the mounting if it does not allow the X-rays an unobstructed path through the pearl to the film. (The mounting may even interfere with X-ray fluorescence testing.)

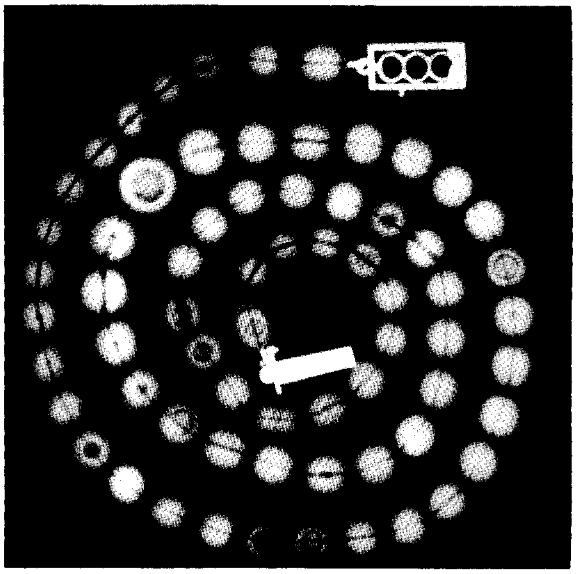


FIGURE 12A RADIOGRAPH OF NATURAL PEARLS

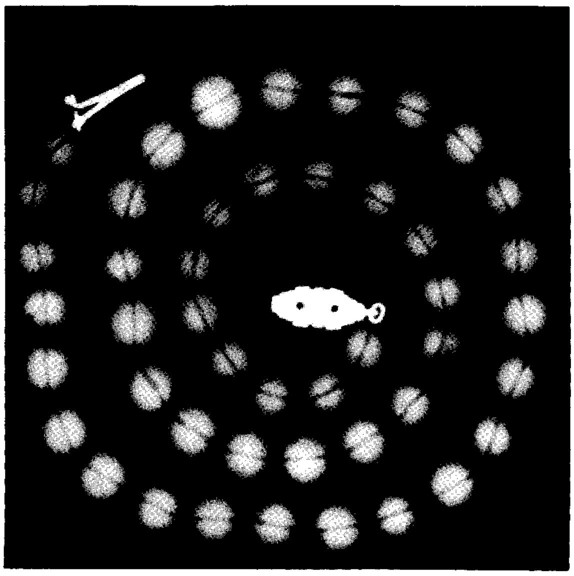


FIGURE 12B RADIOGRAPH OF CULTURED PEARLS

### 2. Fluoroscope Method

Fluoroscopy is a theoretical method that has not proved satisfactory. It involves visual examination of the shadow image of the pearl on a fluorescent screen. Only a very small percentage of cultured or natural pearls actually exhibit a sufficiently clear shadow on the screen to permit interpretation by even the most capable observer. The images also cannot be studied with enough care in the limited time of exposure; moreover, unlike the photographic method, this one produces no permanent record for future reference.

Few jewelers today handle natural pearls in quantity, and a significant proportion of the cultured pearls sold are inexpensive varieties that show enough typical blemishes and other characteristics to permit a trained person to judge that a necklace is cultured. Although the individual pearls might be difficult to identify, the average characteristics in a strand may be sufficient to give a strong indication of their origin. Thus, a poor quality cultured pearl necklace may be detected by the methods outlined in the following paragraphs. A fine cultured strand on the other hand, can seldom be distinguished from a natural strand by such methods. However, since the average jeweler seldom sells expensive cultured and natural strands, inability to distinguish between them is rarely a problem; when difficulty is encountered, the strand can be sent to a GIA Gem Trade Laboratory.

## D. INDICATIONS OF IDENTITY

There are so many "old-wives" tales connected with pearl testing that it is essential to distinguish among so-called tests that are utterly unreliable, tests that offer some indication of identity, and tests that are reliable in every case. First, we will examine a number of external features that are usually visible on cultured pearls, particularly those in the lower price range. These features can normally be seen in diffused white light without benefit of magnification.

Individuals who handle natural and cultured pearls in great quantity can detect the features that characterize Japanese cultured pearls. These are:

(1) a gelatinous appearance, caused by the translucency of the coating
(2) dark welts of irregular shape under the surface, caused by a deposit of dark brown conchiolin before nacre deposition started
(3) protrusions and depressions on the surface
(4) often, a faint greenish cast.

A large proportion of natural pearls have a surface appearance sometimes described as an "orange-peel" or "hammered" effect. However, certain cultured pearls, particularly those with very thick coatings, may have a very similar surface appearance. **Surface appearance, however, is a very doubtful method for distinguishing cultured from natural pearls, since even the experienced observer may be deceived by good quality cultured strands or poor naturals. It is useless for single pearls.**

## E. CANDLING

Other characteristics, somewhat more reliable than those mentioned above, can give an indication of identity for the majority of pearls in a strand; these characteristics are revealed by special lighting. The most effective method of examining low quality cultured pearl necklaces is called **candling.** This method requires an opaque light shield which has a circular opening slightly smaller than the diameter of the pearls being examined. The shield is placed over an intense light source and each pearl is rotated over the circular opening. (The light source of the GIA spectroscope unit makes an excellent candling device.) Most cultured pearls with relatively thin nacreous coatings will reveal a striped effect at some point as they are rotated; this is caused by unequal transmission of light through the flat mother-of-pearl layers in the large nucleus. Cracks near the surface of a natural pearl may produce a similar appearance, but if most of the pearls in a strand exhibit the striped effect, it is likely that they are cultured. The pearls in a fine quality cultured strand may well have a nacreous coating too thick to reveal the striped effect; therefore, failure to detect these stripes is inconclusive and could mean several things: fine cultured pearls with a thicker coating, natural pearls, a weak light source, etc.

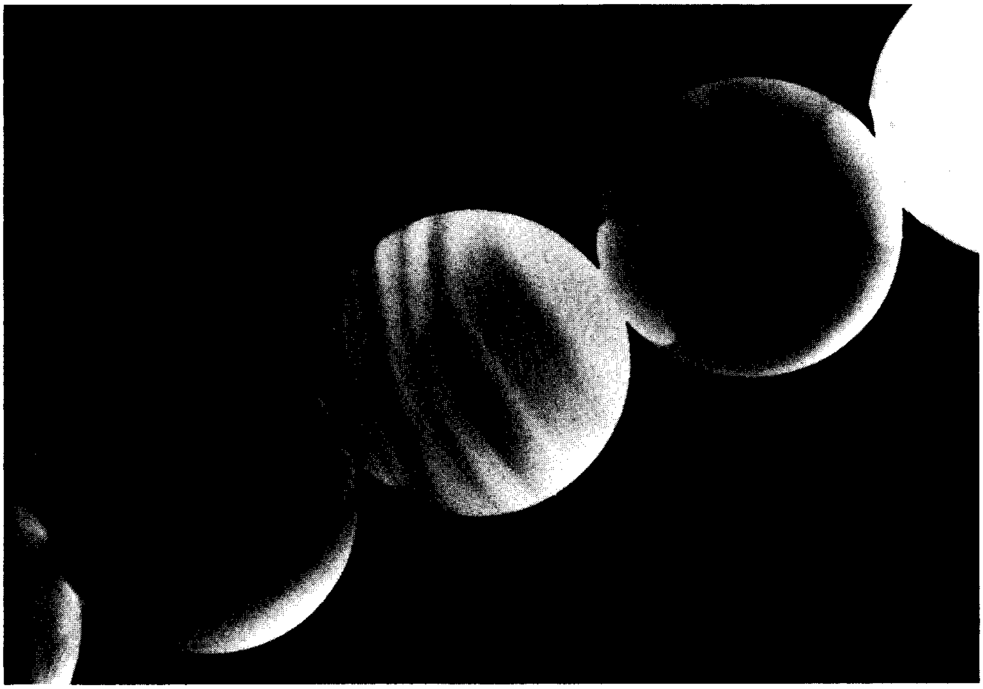


FIGURE 13 THE STRIPED EFFECT THAT MAY BE SEEN WHEN A CULTURED PEARL STRAND IS CANDLED.

If the coating is very thin, simply rotating the strand slowly beneath a strong light source may disclose a difference in the amount of light reflected from two sides of the mother-of-pearl nucleus. The resulting effect, usually referred to as "blinking," is like the adularescence seen in certain directions in moonstone.

Although from a scientific viewpoint the detection of either the striped effect or "blinking" cannot be considered a positive test, when the majority of pearls in a strand exhibit either effect, it is certainly reasonable to assume that the strand is cultured. If all other evidence, such as subsurface dark welts and a bumpy surface, points to cultured origin, a cultured pearl strand is strongly indicated. Absence of any such evidence, however, should never be considered proof that the strand is natural, since these indications apply only to the lowest quality cultured strands.

### F. ENDOSCOPIC METHODS

Several instruments were used in the past to improve the observer's field of view when examining the drill-hole walls of a pearl. Most incorporated a metal needle, the end of which had been cut off at a 45° angle and highly polished to act as a mirror. These instruments were variously known as **endoscopes, pearloscopes,** or **pearlometers,** and the techniques were called **endoscopic methods.** The main disadvantage of these testing techniques was that the pearl had to be drilled and each pearl in a strand had to be tested individually. This was not practical for routine testing because of the time required; therefore, these instruments are of historical interest only and are no longer in use. (For more information on endoscopic methods see Liddicoat's *Handbook of Gem Identification.*)

### G. OTHER TESTS

Many simple tests for separating cultured from natural pearls have been proposed from time to time. Probably the most useful is the examination of the inside of the drill hole with a loupe or microscope. Cultured pearls frequently have a dark line of conchiolin between the mother-of-pearl nucleus and the nacre, and the nacre is usually lighter in color and more transparent than the mother-of-pearl nucleus. Natural pearls are more likely to have many fine concentric rings of conchiolin and nacre. If the tester can see a conchiolin ring and a definite difference in tone between the nucleus and nacre, he can probably assume that the pearl is cultured. You should use this test with caution, however. If a strand has been worn, there may be dirt in the drill hole that looks like a dark line of conchiolin. In addition, the conchiolin may be lightened when the pearl is processed before it is strung. Equally important, some cultured pearls, having a very small nucleus and a very thick coat of nacre due to the longer culturing time, or very thickly coated South Seas cultured pearls might also exhibit fine concentric rings of conchiolin and nacre as far down the drill hole as you can see. This test would not help you separate mantle-tissue nucleated cultured pearls from natural pearls. Thus, if an individual has experience using it, this test would be helpful in a majority of cases. In some instances, however, it would not be conclusive and other means would have to be employed to determine whether the pearl was natural or cultured.

Other tests of little or no practical value are mentioned here only to warn of their unreliability, even as indications of identity. For example, specific gravity is often suggested because the average cultured pearl is very slightly denser than the average saltwater natural pearl; however, the S.G. can overlap significantly. The mean S.G. for Persian Gulf pearls is about 2.71 (range, 2.66-2.76), and the average for mother-of-pearl nucleated cultured pearls is about 2.75-2.76 (range, 2.72-2.78). The S.G. of mantle-tissue nucleated cultured pearls and natural pearls will overlap, and Australian natural pearls range from 2.66 to 2.78.

The only way that this test could provide any reliable indication would be to test all the individual pearls in a strand in a liquid of density 2.72-2.74. If they all floated, this would indicate a natural strand; if they all sank, a cultured one.

However, a mixed strand, one containing both natural and cultured pearls, is always a possibility. For individual pearls, the test is useless. **Its worst drawback is that heavy liquids may cause the pearls to deteriorate more rapidly.**

Fluorescence under ultraviolet radiation (long- or short-wave), either at the surface or in the drill hole, has no diagnostic value since both natural and cultured fluoresce the same.

Another test mentioned in books on gemstones is the "pearl compass," which uses the reaction of minerals to a magnetic field. The pearl is suspended between the poles of a powerful electromagnet. To some degree (however slight), all mineral substances either are attracted by a magnet and tend to align their longest dimensions parallel to the magnetic field (these are paramagnetic), or are repelled and tend to align their longest dimensions at right angles to the field (diamagnetic). Pearls and mother-of-pearl are diamagnetic. Since a cultured pearl, although round, is normally composed largely of a nucleus made up of flat layers, in a strong magnetic field it should tend to rotate until the longest dimensions of the mother-of-pearl nucleus are arranged at right angles to the field. A natural pearl, because of its uniformly concentric structure, should remain stationary under identical conditions. Although this is theoretically plausible, actual testing by this method has proved indefinite and of little practical value, due perhaps to the structural variations in both natural and cultured pearls (or the torsional properties of the suspension string).

## H. SUMMARY OF TESTING METHODS

The various testing methods used in separating natural and cultured pearls can be summarized as follows, in order of decreasing reliability:

1. Careful X-radiography by the photographic method used in conjunction with X-ray fluorescence testing provides **positive proof** of the identity of unknown pearls. It also provides a permanent record for future reference.
2. X-ray fluorescence by itself provides information that is helpful in identification even though it lacks the reliability of the radiographic technique.
3. X-ray diffraction provides positive proof in **most** cases but may give false results. It may be considered a **supplementary** test.
4. The fluoroscope method done with wide beam X-rays is **unreliable** because of the lack of contrast and definition in the shadow image.
5. The endoscopic methods are of historical interest only. However, examination by magnification of the drilled hole for the existence of the conchiolin layer in cultured pearls is probably the most reliable of the tests other than X-ray.
6. All of the other tests described provide only **partial indications** of identity.

## XIII. EVALUATION

The value of cultured pearls is affected by the same factors as natural pearls (color including orient, luster, shape, blemishes, size, etc.). One further special consideration with cultured pearls is the thickness of the nacreous coating. Those with thin outer coatings may crack under sharp blows or heavy pressure and are therefore not desirable. Also, a thin coating may wear away completely and expose the mother-of-pearl nucleus, especially on pearls at the ends of a necklace and with persons who have acidic skin oils. Cultured pearls thus damaged cannot be repaired, whereas natural pearls sometimes can. The thickness of the coating can often be determined by observing the position of the concholin layer in the drill hole. (As with natural pearls, the size of the drill hole should be just large enough to accommodate the stringing thread. However, cultured pearls are frequently drilled with larger holes to reduce drill-bit breakage and allow faster drilling.)

An increasing number of cultured pearls are artificially colored pink, blue, black, and other colors to disguise the common green tint that some regard as undesirable. One method is to dip poor quality pearls in a brownish black dye; the dyeing solution, however, remains at the surface and obliterates any luster and orient present. A more effective method is injection of a chemical in a half drilled pearl. A slow reaction takes place from the inside out, making the color penetrate evenly. This treatment, done primarily in France, is superior to dyeing because luster and orient are unaffected; moreover, the color is more attractive and does not fade. Another method of blackening cultured pearls uses silver salts. The pearls are put into a silver oxide powder for weeks, then into a silver nitrate solution. The free silver thus deposited leaves a black color; and the pearls still retain some of their original luster and orient.

Although the term "very finely matched" implies exact matching, it actually refers to the **blending** of cultured pearls that have very similar characteristics; all pearls in a given section of a necklace will **appear** to be the same in all of their qualities, and the necklace as a whole will present a uniform overall appearance. Exact matching is usually done only on **pairs** of pearls. If two cultured pearls are matched exactly, their value as a pair can be up to 30% more than the sum of their values before matching.

The following factors may be used in establishing the relative values of cultured pearls.

### A. COLOR

The two most desirable colors are: (1) pink rosé — a pink body color with a rosé overtone; and (2) white rosé — pure white with a rosé overtone. (Note: This pure white must not be confused with white pearls that lack translucency and orient.) South Sea cultured pearls nearly always have a brownish, golden, white, or silvery body color.

### B. LUSTER

"Very fine luster" means high luster of even intensity (equal in all areas of the pearl).

### C. NACREOUS COATING THICKNESS

A well coated cultured pearl produced in Japanese waters will have a nacreous coating approximately 0.5 mm thick. Nuclei left in the oyster one year will be covered with only 0.15 mm of nacre or less.

### D. SHAPE

A cultured pearl described as "round in shape" would theoretically be perfectly spherical. In practice, however, this phrase refers to pearls that are sufficiently round to appear spherical to the eye; these command the highest prices. The more deviation from a spherical shape, the lower the value.

### E. FREEDOM FROM ALL FLAWS

A gem-quality cultured pearl should be free from flaws of any kind.

The prices of loose, undrilled cultured pearls show a greater variation than the prices of strands for the following reasons: (1) Drilling can usually be planned to eliminate certain flaws, but this option is unavailable on an already drilled pearl; (2) single pearls or small groups of pearls are usually more carefully examined and graded than strands; (3) smaller quantities are being sold. Loose cultured pearls are sold by size, not weight.

## XIV. BUYING AND SELLING

Traditionally pearls have been a dressy item, the perfect accessory with basic black. However, the development of freshwater mantle-tissue cultured pearls has changed the pearl's image forever. These cultured pearls are a versatile accessory offering a palette of colors, a variety of lusters, and a choice of shapes. They coordinate beautifully with frilly feminine fashions, yet they can be worn casually, even with jeans. Young people, who feel that spherical pearls are staid and old fashioned, are often particularly attracted to the unique colors and shapes of freshwater cultured pearls. These pearls have steadily gained in popularity since they were introduced to the jewelry market.

Fortunately, the interest in freshwater cultured pearls (mantle-tissue) has rekindled interest in traditional round cultured pearls. Fashion designers seeking elegant, luxurious looks increasingly use strands of uniform round cultured pearls as accessories. These designers capitalize on the pearl's traditional reputation as a sumptuous, expensive gemstone while using it in novel, nontraditional designs. Today women of fashion wear woven ribbons of cultured pearls as chokers or "scarves"; they use strands of cultured pearls as chains for colored stone pendants or as accents for other jewelry. Fashion leaders constantly explore new ways to use pearls; they feature models who combine ropes of pearls with pins, and entwine strands of pearls with colored stone beads or silk scarves. By studying the fashion world's use of pearls, you and your salestaff can demonstrate their range and versatility in your sales presentations and displays.

FIGURE 14 FRESHWATER CULTURED PEARLS COME IN A VARIETY OF SHAPES, SIZES, COLORS, AND LUSTERS.

The baroque shapes and unusual colors of freshwater cultured pearls (mantle-tissue) are more suited to men's jewelry than the shapes and colors of traditional round pearls. Today's jewelry designers are using these pearls to create unique and elegant men's jewelry. Freshwater cultured pearls are particularly successful in cuff links. Although both tie tacs and cuff links go in and out of style, men who like jewelry will wear them, regardless of fashion. Remember to consider freshwater cultured pearls when you are looking for fresh ideas in men's jewelry. They give you the opportunity to offer your male customers something new, unusual, and elegant.

Many jewelers have been very pleased with the results of coordinating their advertising and window displays for a pearl promotion each year. The best time to initiate such a promotion is early in the year just before Valentine's day. By running your promotion through the spring you can feature pearls for Valentine's day, Mother's day, and the June bridal season. The late spring is also a time when people are selecting graduation gifts. Since pearls are a traditional jewelry item, they are appropriate for all of these occasions. Remember to time your promotion to be in full swing through the month of June when the pearl is one of the birthstones of the month. When you are planning it, take a few tips from department store promotions. In your advertising, feature a free pair of cultured pearl stud earrings with every cultured pearl necklace purchase. Mention that you'll include a velvet necklace case, especially if that's already store policy. This same promotion might also be very effective during the Christmas holiday season.

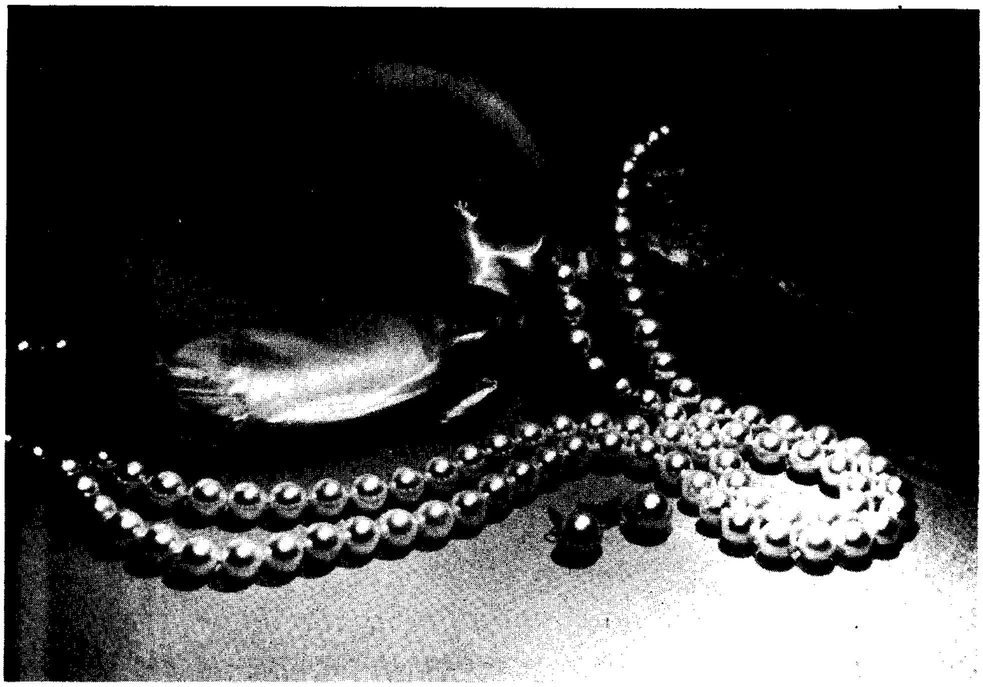


FIGURE 15 SHELLS, DRIFTWOOD, CORAL, ETC. CAN ENLIVEN YOUR PEARL DISPLAYS.

Whether your store features pearls once a year or all year round, you will find that cultured pearls give you the opportunity to offer your customers traditionally valued, yet moderately priced jewelry that is beautiful, versatile, and fashionable.